International Journal of Financial Management and Economics

P-ISSN: 2617-9210
E-ISSN: 2617-9229
IJFME 2024; 7(1): 261-267
www.theeconomicsjournal.com
Received: 04-04-2024
Accepted: 06-05-2024

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Revisiting the Environmental Kuznets Curve (EKC) Hypothesis in India: The Role of Crude Oil Consumption

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DOI: https://doi.org/10.33545/26179210.2024.v7.i1.300

Abstract
The study investigates the dynamic relationship between crude oil consumption, economic growth, and carbon emissions. The study revisits the position of the environmental Kuznets curve (EKC) hypothesis in India by integrating the function of environmental deterioration with role of crude oil consumption. Energy consumption has increased significantly since 2000, with coal, oil, and solid biomass still meeting 80% of the demand. Crude oil constitutes 80 to 87 percent of carbon, and India is the third largest crude oil consumer globally. As per the Indian Energy Outlook Report 2021, India experiences the most remarkable rise in energy demand of any nation in all our scenarios to 2040 due to its growing economy, population, urbanization, and industrialization. Crude oil consumption and imports proliferate due to rising vehicle ownership and road transport use. Oil demand has more than doubled since 2000 due to growing vehicle ownership and road transport use. India is the third-largest global emitter of CO_2, despite low per capita CO_2 emissions, as per IEA, 2021. As crude oil is demanded by every sector, such as industry, transport, buildings and agriculture, greater demand comes from the transport sector. Freight transport contributes to nearly half of the CO_2 emissions from road transport, i.e., more than 45 percent. India, the fastest-growing economy, and the third-largest energy-consuming country have been investing significantly in renewable energy to make clean energy. The study aims to analyse the relationship between economic growth and emission from crude oil consumption as per capita in India. Although carbon emissions from energy consumption and economic growth nexus are studied in the literature, this is the first study to examine the effect of economic growth on emissions from crude oil consumption in India. This study is critical as India has a significant role in the world in both economic and environmental terms. The study estimates the Environmental Kuznets Curve (EKC) for India by employing time series data from the period of 1990-2020. The study tests the Environmental Kuznets Curve hypothesis based on secondary data with reference to India; an empirical model is tested to analyse the relationship between CO_2 emissions (in per capita metric tonnes) from oil consumption and real GDP (per capita). The empirical findings of the study support the existence of the EKC hypothesis. The study reveals that per capita growth tends to improve environmental quality. The study suggests that at a broad level of development, per capita emissions of CO_2 emission begin to decline. The acceptance of EKC suggests that economic development at early stages may lead to environmental damage, but significant improvement is possible at later stages. Evidence suggests that while early economic development may contribute to environmental harm, later stages of development offer the potential for significant progress and improvement. The acceptance of EKC underscores this dynamic relationship between economic growth and environmental sustainability.

Keywords: Environmental kuznets curve, carbon emission, crude oil consumption, India, environmental sustainability, ARDL

Introduction

Grossman and Krueger's (1995) [24] the Environmental Kuznets Curve (EKC) hypothesis proposes a distinctive correlation between economic growth and emissions. It posits that environmental pollution increases in tandem with economic growth in the early stages of development but once the per capita income reaches to threshold level, it eventually leads to significant reductions in pollution. This suggests a positive correlation in the first stage and an inverse relationship in the second stage between economic growth and environmental quality. The relationship between economic growth and environmental quality is determined by three effects: scale, technique, and composition.

The scale effect indicates an initial positive relationship, the composition effect proposes a probable U-shaped relationship, while the technique effect suggests an inverse relationship between economic growth and pollution due to improved technologies. Recent investigations have extended the debate over the relationship between pollution, economic growth and the validity of the Environmental Kuznets Curve (EKC) hypothesis across different countries and time periods. These studies have revealed that the shape of the EKC curve can be U-shaped, inverted U-shaped, N-shaped, or inverted N-shaped depending upon the sample countries, time period covered and indicators taken.

There is a complex relationship between carbon dioxide (CO_2) emissions and economic growth in India. Researchers have observed a positive linear relationship between economic growth and CO_2 emissions in India (which have observed linear relationship between economic growth and CO_2). This relationship suggests that as India's economy grows, there is a corresponding increase in CO_2 emissions. The reason behind such relationship comes from the fact that development is an outcome of increased industrial activity, urbanization and greater consumption of manufactured goods and services, contributing to higher CO_2 emissions. Indian policy makers relied on this path of economic progress and given high impetus to industrial activities and industry-led services (like manufacturing, construction, etc.), which tend to have high carbon footprints. Furthermore, with increase in level of development, demand for fuel, power and energy also risen manifold. This increased demand for energy mainly relies on fossil fuels, which is a major source of CO_2 emissions.

This relationship between economic growth and CO_2 emissions in India highlights the challenge of balancing economic development with environmental sustainability. It highlights the need for sustainable development strategies that promote economic growth while simultaneously reducing CO_2 emissions. Furthermore, it is essential to implement policies and initiatives that encourage a shift towards cleaner and more sustainable energy sources, such as renewable energy sources. Using time series data and advanced statistical estimators, researchers have identified the positive association between economic growth and CO_2 emissions in the ASEAN nations also (having similar geographic and economic conditions) such as Malaysia, Thailand, Vietnam, Indonesia, and Philippines. The findings of these studies suggest that as economic growth and energy use increase, CO_2 emissions also increase. The positive relationship between economic growth and CO_2 emissions in ASEAN nations reinforces the need for sustainable development strategies that encourage greener forms of energy production and reduce dependency on fossil fuels. Similarly, studies conducted on CIVETS countries, including Colombia, Indonesia, Vietnam, Egypt, Turkey, and South Africa, have also shown a positive correlation between economic growth and CO_2 emissions. Similar findings have been observed in the case of the BRICS and African nations.

Bashir *et al*. (2021) [25] argued that India has been understudied in relation to the EKC hypothesis. Most scholars have focused on China and the USA, followed by Turkey and Pakistan. However, India is one of the top 10 CO_2 emitters and a significant emerging economy. It is the second largest CO_2 emitter, China being the first, among the emerging economies (Neog & Yadava, 2020) [26]. According to Yang *et al*. (2021) [27], India is one of the world's top four most polluted economies. Notably, approximately 40 percent of greenhouse emissions come from the BRICS countries, among which India is prominent. Additionally, the International Monetary Fund (IMF) has acknowledged India's position as one of the fastest-growing economies in the world and its dedication to sustainable growth.

India's crude oil consumption largely met by imports. The reliance on imports for meeting consumption demand in continuously increasing. A staggering 85 percent of the total domestic consumption is being met through imports in 2020-21. According to BP PLC, India’s oil consumption was 5,185 Barrel/Day the in December 2022, which is an increase from the previous year’s consumption of 4,798 Barrel/Day, i.e., 8.07 percent rise and the level of economic growth per capita was 2388.6 in 2022 which is increased from the previous year which was earlier 2238.1 in 2021, i.e.,6.7 percent rise. As far as Indian economy is growing, the demand for crude oil is also increasing for a better standard of living which will boost economic growth but at the same time will affect environment sustainability. This puts the nation's security at risk in the event of global supply chain disruptions or geopolitical tensions. India’s crude oil consumption is increasing steadily over the years.

Against this background, the main objective of study to investigate applicability of EKC hypothesis from the perspective of relationship between carbon emissions from crude oil consumption and India's economic growth from 1990 to 2020.

The paper is divided into five sections. Section II provides a critical review of relevant literature on the EKC and its applicability in Indian scenario. Section III presents data and methods used, including the autoregressive distributed lag (ARDL) model estimation strategy. Section IV reports the empirical results. Finally, the conclusion and policy implications are discussed in section V.

Literature review

The concept of EKC was initially made popular by the World Bank Report 1992 and Grossman and Krueger (1995) [24], who used a simple empirical technique to present evidence on the correlation between environmental quality parameters and national GDP levels. According to this research, environmental degradation and per capita income generally have an inverted U-shaped relationship, with pollution rising with income at low-income levels and falling at high-income levels. As environmental degradation is becoming a rising concern due to global warming, a significant amount of research has taken place on the relationship between emissions and economic growth since 1990. The available literature on the topic can be categorised into three segments. The first segment focuses on the economic growth and emission nexus. For instance, Beşe and Friday (2021) [7] investigate the impact of economic growth and emissions from coal consumption per capita in India from 1960 to 2019. The results of the study demonstrate that the relationship between coal consumption emission and economic growth in short run is significant but in long run insignificant. Also shows insignificant N-shaped association between economic growth and environmental degradation.

Sinha and Bhatt (2017) [15] analysed the linkages between environmental deterioration and economic expansion proxied by NOx, CO_2, and GDP respectively. By performing cubic and quadratic regressions, they found that the EKC for GDP and carbon emission is inversely N-shaped, while the EKC for NOx and CO_2 emission is N-shaped. Sultan *et al*. (2021) [14] investigated the causal relationship between CO_2 and economic growth in India based on the EKC hypothesis using the Johansen method of cointegration. The study found that there is a long-run cointegrating relationship between the variables of the study. Furthermore, the result showed that the EKC hypothesis is validated in India. The second segment focuses on the economic growth-CO_2-energy nexus. Zhang and Cheng (2009) [13] study applies a multivariate model, which includes data on urban population and gross fixed capital creation, to examine the inter-temporal relationships in the energy-environment-income nexus for China between 1960 and 2007. According to the study's empirical results, there is a long-term unidirectional Granger causal relationship between GDP and CO_2 emissions and between GDP and energy consumption. Evidence shows policies to reduce carbon emissions without having an adverse long-term impact on economic growth. It also revealed that neither energy use nor carbon emissions drive economic growth. Tiwari (2011) [12] examined the static and dynamic relationships between economic growth, CO_2 emissions and total energy consumption in India by performing the Granger technique in the VAR framework. Through VAR analysis, it was found that energy consumption Granger causes CO_2 emissions but not vice-versa. The finding from Dynamic Granger indicates that CO_2 emission positively affects capital and energy usage, and energy consumption positively affects CO_2 and GDP. Energy consumption hurts capital and population, while CO_2 emissions hurt GDP and population. Özden and Beșe (2021) [7] using ARDL and NARDL model, investigated the connection between GDP, square of GDP, CO_2 and energy consumption. Moreover, EKC for Australia was examined and determined that no asymmetric or symmetric relationship was found between GDP and CO_2. Also, Australia's EKC hypothesis has not been verified from 1960 to 2014. Furthermore, there was no evidence of a causal link between GDP, GDP squared, or energy use and CO_2.

The third segment focuses on the GDP-CO_2-energy-trade nexus. Tiwari *et al*. (2013) [11] aims to investigate the EKC within the framework of the Indian economy. The dynamic relationship between coal use, economic growth, trade openness, and CO_2 emissions for India from 1966 to 2009 was examined. The study found the existence of EKC in the long and short run. According to the causality analysis, a bidirectional causal relationship between economic growth and CO_2 emissions was reported. Furthermore, trade openness Granger increases in CO_2 emissions, coal consumption, and economic growth. Similarly, Jayanthakumaran *et al*. (2012) [10] studied inter-linkages among economic growth, CO_2 emissions, trade, and energy consumption and attempted to find evidences of the EKC hypothesis. The study also looks for structural breaks in these crucial variables in the context of China and India. Finding shows the validity of the EKC hypothesis for both China and India. Furthermore, the study highlights that energy consumption, structural breaks, and per capita income all impacted China's CO_2 emissions. However, a similar causal relationship between structural breaks and CO_2 emissions cannot be shown for India. Alam and Adil (2019) [8] performed an ARDL bounds testing approach to cointegration among CO_2, economic growth, primary energy supply, financial development and trade openness in India. However, results reveal that the relationship between CO_2 and economic growth is insignificant, while between energy supply and carbon emissions establishes a significant positive relationship. Therefore, the EKC phenomenon does not exist in India.

Usman *et al*. (2019) [5] analysed the role of income, energy consumption and democracy on environmental degradation measured by CO_2 in the context of validating the EKC hypothesis for India over the time frame 1971-2014. The study confirms the existence of the EKC hypothesis in India. It further notes that energy use was linked to an increase in environmental degradation over the long and short run. The effect of democracy in reducing environmental degradation in the long run is weak but strong in the short run. Therefore, the study suggests that an energy conservation policy should be implemented to reduce CO_2 and boost economic growth. Verbič *et al*. (2021) [6] confirms in their study that the EKC hypothesis is valid in the long term while in the short term verified only for Greece and Moldova while examining the short-term and long-term relationship among real GDP per capita, energy consumption, urbanization and CO_2 in ten Southeastern European countries. Adamu *et al*. (2019) [9] investigated the EKC hypothesis along with the impact of energy, export variety, and foreign direct investment (FDI) on environmental degradation in India over the period of 1983 to 2014. Their result shows that the EKC hypothesis does not hold in India.

It can be concluded from the literature review that there is no conclusive evidence about the existence of the EKC hypothesis in case of India. The present study further extends this debate and contributes to existing literature in two ways. First, in the last twenty years, India has experience significant economic progress. The per capita income during this period grew more than double. The increased standard of living will also ignite greater focus on environmental quality. Thus, the evidences on the basis of current experience will be more conclusive. Second, the present study test the EKC hypothesis by examining relationship between economic growth and emissions from crude oil consumption in India.

Data, estimation techniques, model specification

Model Specification

Based on the stated objective of this study and insights from related previous investigations, following empirical model is adapted to test the EKC hypothesis for India.

$$CO_2 = f(PCGDP_t, PCGDP^2, PCGDP^3) \quad (1)$$

Where CO_2, and *PCGDP*, $PCGDP^2$ $PCGDP^3$ denote carbon dioxide emissions from crude oil consumption (proxy variable for environmental degradation), per capita gross domestic product - proxy variable for economic growth, the square value of economic growth, the cubic value of economic growth, respectively. The econometric specification of the model with the addition of the stochastic error term and the logarithmic notation (ln) is presented in Eq. (2).

$$lnCO_2 = b_0 + b_1 lnPCGDP_t + b_2 lnPCGDP_t^2 + b_3 lnPCGDP_t^3 + \varepsilon_t \quad (2)$$

It is imperative to highlight that all the series have been defined earlier, and such definitions are retained in Eq. (2) and in subsequent equations. Accordingly, In CO_2 (environmental quality indicator) is the dependent variable, In *PCGDP* is the principal regressor used to explore the possible validation of the EKC hypothesis.

We present the Eq. (2) on the ARDL framework. The ARDL model is as follows.

$$\Delta lnCO_{2t} = \beta_0 + \beta_1 lnCO_{2t-1} + \beta_2 lnPCGDP_{t-1} + \beta_2 lnPCGDP_{t-1}^2 + \beta_3 lnPCGDP_{t-1}^3 + \sum_{j=1}^{p} \varphi_j \Delta lnCO_{2t-j} + \sum_{i=0}^{q} \theta_1 \Delta lnPCGDP_{t-i} + \sum_{k=0}^{q} \theta_2 \Delta lnPCGDP_{t-k}^2 + \sum_{l=0}^{q} \theta_3 \Delta lnPCGDP_{t-l}^3 + v_t \quad (3)$$

The cointegration relationship of the long-run variable in Eq. (3) can be estimated through the underlying null hypothesis: $\beta_1 = \beta_2 = \beta_3 = 0.$ The bound tests can be calculated through the critical values provided by Pesaran and Shin and applied by Pal and Mitra (2019) [1]. The null hypothesis of no short- and long- run asymmetries are estimated following the procedures stated herein: H_O: $\theta_1 = \theta_2 = \theta_3 = 0$ and H_O: $\beta_1 = \beta_2 = \beta_3 = 0.$

Data

GDP per capita (constant Local Currency Unit) is taken from the World Development Indicators – World Bank and CO_2 emission by crude oil consumption (Metric tons per capita) is taken from the Centre for Monitoring Indian Economy (CMIE) for the period 1990-2019.

Data Analysis and Discussions

The empirical outcomes of this study emanate from several rigorous analyses, including very relevant pre- and post-estimation diagnostic investigations. Table 1 presents the unit-root tests based on the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) [2] test.

Table 1: Unit Root Test

Variable/ Test	KPSS		
At level			
CO_2 Emission	0.1378		
GDP	0.1999**		
GDP^2	0.2211***		
GDP^3	0.2354***		
At First Difference			
CO_2 Emission	0.0693		
GDP	0.1338		
GDP^2	0.1315		
GDP^3	0.1288		
Critical Values	10%	5%	1%
	0.146	0.176	0.216
Null Hypothesis	Stationary		

Note: Authors' Calculation on R Studio

Table 1 represents the KPSS (1992) test result and it shows that CO_2 Emission is stationary at level, while all other variables are stationary at first difference. To verify the results, we have applied Zivot and Andrews (1992) [3] unit root test in Table 2. The test will help us to know the break point in the data as well as show the stationarity level of the variables.

Table 2: Zivot and Andrews Unit Root Test

Variables	Level	Break Point	First difference	Break Point
Ln (CO_2 Emission)	-3.3101	2002	-5.0535**d	2014
Ln(GDP)	-3.1989	2019	-5.3867**	2017
Ln(GDP^2)	-2.8271	2019	-5.3244**	2017
Ln(GDP^3)	-2.6407	1990	-5.2605**	2017

Note: ***p*<0.05.

As our variables are stationary at I(0) or I(1), the ARDL method is appropriate for testing short- and long-run relationship between the concerned variables.

In table 3, the ARDL Bound Cointegration test was applied to know the long run cointegration of model presented in Eq. 2.

Table 3: Bound Test Result

Bound Test	F. Stat.		
F test	4.480739		
Critical Value I(0)	10%	5%	1%
	3.008	3.71	5.333
Critical Value I(1)	10%	5%	1%
	4.15	5.018	7.063

Note: Authors' Calculation on RStudio

Table 3 shows the long-run bound testing results, F statistics (4.48) is lower than the upper bound critical value (5.018) at a 5% significance level. These results clarify that there is no long-run relationship between the variables. The table 4 ARDL short run model was estimated.

Table 4: ARDL Short-run model

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-918.5154	313.0473	-2.934	0.00927***
emission.1	-0.7606	0.1656	-4.592	0.000177***
GDP.1	572.3531	197.1675	2.903	0.00990***
GDP2.1	-119.1499	41.4701	-2.873	0.01055***
GDP3.1	8.2798	2.9107	2.845	0.01120***
DGDP.T	2561.0587	669.1822	3.827	0.00135***
DGDP.1	-1320.3444	930.3231	-1.419	0.17391
DGDP2.T	-535.7031	139.7356	-3.834	0.00133***
DGDP2.1	278.9842	200.2888	1.393	0.18160
DGDP3.T	37.3363	9.7192	3.842	0.00131***
DGDP3.1	-19.6575	14.3637	-1.369	0.18896
demission.1	0.5040	0.1791	2.814	0.01195***
R-squared	0.8505	Adjusted R-squared	0.7537	
F-statistic	8.789	P. Value	0.0000***	

Note: Authors' Calculation on RStudio; ***1%, **5% Significance

Table (4) shows that all variable at their 1st lag is significantly impacting the emission while the result is providing a base for OLS result as all the variables are showing same relation with the dependent variable as the prior had shown. From Table 4, the impact of linear and non-linear terms of real GDP per capita is positive and negative. The coefficients of linear and non- linear are (572.3531) and (-119.1499) and it is statistically significant at 1% level of significance, respectively. The significance of both linear and non-linear terms of real GDP per capita provides the empirical evidence of inverted U-shaped

relationship between economic growth and CO_2 emissions, so called environmental Kuznets curve, (EKC). The empirical exercise revealed that 1% increase in GDP per capita are linked with 572.35% increase in emission from crude oil consumption and the inverse effect of squared term of real GDP per capita shows the delinking point of CO_2 emission i.e., (-119.14%), once an economy achieves higher level of growth. The results for cubic terms of real GDP are statistically significant at 1% significance level and the coefficients are (8.2798), which shows a positive relationship between emissions and economic growth, i.e., after a certain point rise in the cubic terms of real GDP will make emission increase.
After providing short run result we have provided long run result model in the next table (5).

Table 5: Long-run model

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-918.5154	313.0473	-2.934	0.009***
emission.1	-0.7606	0.1656	-4.592	0.000***
gdp.1	572.3531	197.1675	2.903	0.010***
gdp2.1	-119.1499	41.4701	-2.873	0.011***
gdp3.1	8.2798	2.9107	2.845	0.011***

Note: Authors' Calculation on RStudio; ***1%, **5% Significance.

The long run model result shows that all the variables are significant with the dependent variable. After this table (6) shows the error correction model.

Table 6: Error Correction Model

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-918.5154	313.0473	-2.934	0.00927***
EC.1	-0.7606	0.1656	-4.592	0.000177***
DGDP.T	2561.0587	669.1822	3.827	0.00135***
DGDP.1	-1320.3444	930.3231	-1.419	0.17391
DGDP2.T	-535.7031	139.7356	-3.834	0.00133***
DGDP2.1	278.9842	200.2888	1.393	0.18160
DGDP3.T	37.3363	9.7192	3.842	0.00131***
DGDP3.1	-19.6575	14.3637	-1.369	0.18896
demission.1	0.5040	0.1791	2.814	0.01195**

Note: Authors' Calculation on RStudio; ***1%, **5% Significance.

The error correction term suggest there is a significant short run equilibrium in the data. From the result of ARDL model it clear that economic growth has a positive impact on the CO_2 emission from crude oil, while square of economic growth has a negative impact. After ARDL model formation and specification we are going to check the stability of ARDL model with the help of CUSUM, CUSUM SQ., and MOSUM test. Fig. 3 shows the stability plots of the model.

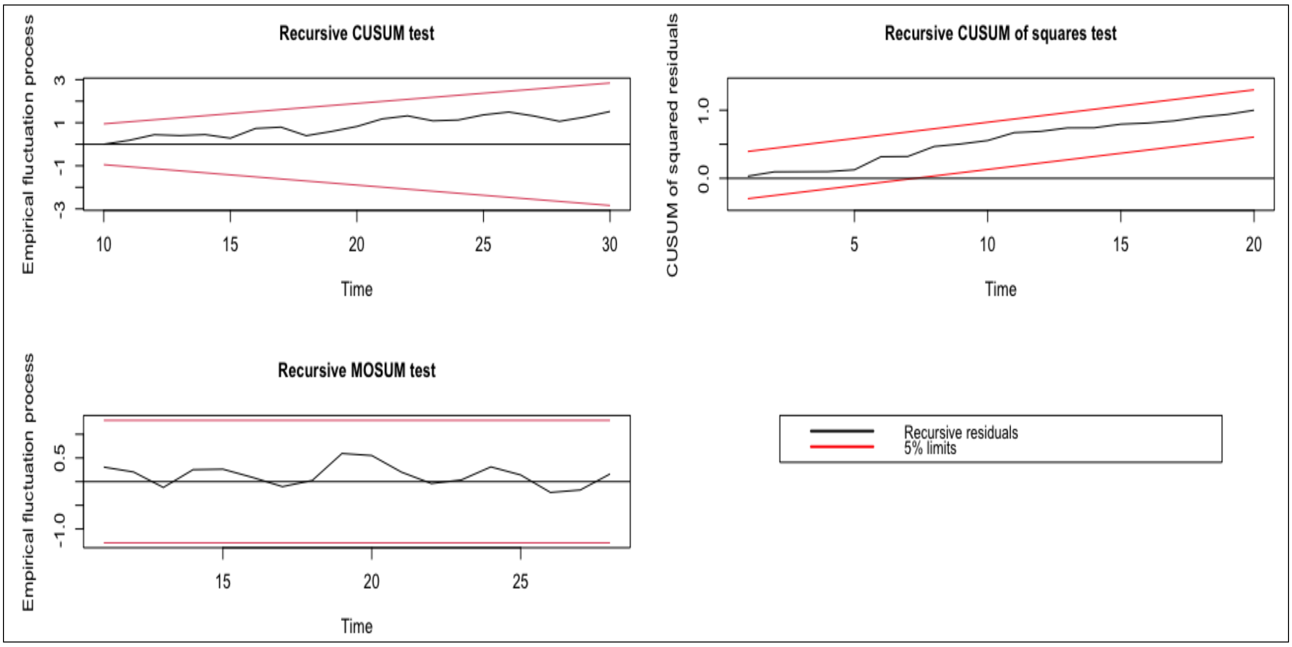

Fig 1: Stability Test of Auto Regressive Distributed Lag Model

The Fig. 1 shows that the model's residuals are stable in all the recursive test. To check further the robustness of the model, in the table (7) we shown the test result of ARDL model.

Table 7: Test Result of ARDL Model

Test	Stat.	P. Value
Breusch – Godfrey test	0.19149	0.6675
Ljung and Box test	0.13359	0.7147
Breusch and Pagan test	10.61	0.4765
Shapiro and Wilk test	0.97801	0.7855
RESET test	2.1457	0.146

Note: Authors' Calculation on RStudio

Table 7 shows the robustness of the ARDL model. The Breusch – Godfrey test for autocorrelation has a null hypothesis of no serial correlation, and our result shows that the ARDL model doesn't have a serial correlation. The Ljung and Box (1978) [19] test verifies the same result. For homoskedasticity, we have applied the Breusch and Pagan test, which has a null hypothesis of homoscedastic residual, and from our result, we accepted the null hypothesis. For normality, the Shapiro and Wilk normality test was applied, which has a null hypothesis of customarily distributed residual; for this, we can also not reject the null hypothesis. The Ramsay RESET test shows that we have no omitted variable in the model.

Conclusion

The paper aims to verify the EKC hypothesis in the case of India, which is to measure the relationship between carbon emission by crude oil consumption and economic growth. Applying the ARDL method to the data from 1990 to 2020, we find that environmental degradation measured in terms of carbon emission per capita and economic growth measured by GDP per capita has a short-run cointegration relationship. The relationship is statistically significant in the short run but insignificant relationship in the long run.

From the above analysis, we can conclude that the Environmental Kuznets Curve Hypothesis exists in the case of the Indian economy. From our result, GDP per Capita has a positive relationship, the square of GDP per Capita has a negative relationship, and the cubic of GDP per Capita has a positive relationship with carbon emission from crude oil consumption, indicating that economic growth is following the pattern of EKC hypothesis in case of India. From this, it can be concluded that CO_2 emission from Crude Oil Consumption follows an inverted U shape model. A rise in economic growth raises demand for crude oil that emits energy pollutants.

The study does not confirm the relationship between emissions and economic growth in the long- run in per capita terms. Therefore, our findings demonstrate that relying on crude oil consumption to stimulate economic growth may be a viable solution in the short term. However, in the long term, we must seek out alternative options, as crude oil consumption results in increased CO_2 emissions that can harm economic growth. Our team has put together several recommendations for Indian policymakers to consider bolstering the country's economic growth and reducing CO_2 emissions: (1) Opening up India to foreign investment, particularly in advanced technologies and expertise, could be a crucial driver of economic growth. (2) Encouraging the free flow of Foreign Direct Investment (FDI) would introduce new ideas, technologies, and management strategies to domestic firms, reducing CO_2 emissions. (3) We recommend promoting initiatives that facilitate the provision of ongoing technological support from foreign companies to domestic firms, including worker training and the introduction of new technologies. This approach can potentially reduce CO_2 emissions, spur economic growth, and reduce reliance on crude oil consumption without impeding progress toward higher economic growth.

The main results of this study are as follows

- In the short run, a significant relationship exists between carbon emissions and economic growth in India.
- In the long run, there is an insignificant relationship between carbon emissions and economic growth in India.
- The study confirmed the existence of the EKC hypothesis in the context of the Indian economy.

The study recommends that future studies may analyse total emissions from total energy consumption for different periods with different methodologies in different sectors of the Indian economy as well as for other developing economies to further contribute to the literature.

Acknowledgement

The author acknowledges ICSSR, New Delhi, for the award of a Full-Term Doctoral Fellowship in providing financial support for carrying out research. The research paper forms part of the research work sponsored by ICSSR under the provision of a Full-Term Doctoral Fellowship for the Research Scholars.

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